Silica

For water and seawater **Silicomolybdate/Heteropoly Blue Method**

Introduction

Silicon is the second most abundant element in nature. Accordingly, it is not surprising that most waters contain compounds of silicon, usually as silica (SiO_2) or silicates (SiO^{4-} and SiO_3^{2-}). Silica concentration in water is commonly less than 30 mg/L, although concentrations greater than 100 mg/L are not unusual; concentrations exceeding 1000 mg/L are possible in brines and brackish water.

Silica and silicates are added to water for a number of uses, such as water conditioners, detergents, and corrosion inhibitors. However, silica in water can cause significant problems for industries, primarily in boiler and turbine applications. High pressures and high temperatures cause silica deposits on tubes of boilers and heat exchangers. These glassy deposits lower the efficiency of heat transfer and lead to premature failure. Silica deposits on steam turbine blades decrease efficiency and necessitate costly downtime for cleaning. Silica levels must be kept below 0.005 mg/L in very high pressure applications.

Measuring silica in water is useful when efficiency of demineralizers is monitored. Testing for silica (one of the first impurities detected when the exchange capacity of a demineralizer is exhausted) provides a sensitive check of demineralizer performance.

Analytical procedures for silica include the Silicomolybdate Method for high range measurement and the Heteropoly Blue Method for low range measurement. The Heteropoly Blue method is an extension of the Silicomolybdate method to increase sensitivity.

Chemical reactions

High and low ranges
The Silicomolybdate Method involves the reaction of molybdate ion with silica and phosphate under acid conditions to form a yellow color. Citric acid is added to destroy the phosphomolybdic acid complex (the yellow color formed due to phosphate), but not the silicomolybdic acid complex. For large amounts of silica, the remaining yellow color is intense enough to be read directly. For low concentrations, an amino-naphthol sulfonic acid reducing agent is used to convert the faint yellow color to a dark heteropoly blue species. The color formed is directly proportional to the amount of silica present in the original sample; a colorimetric measurement of this intensity provides an accurate means of determining the silica concentration. Some forms of silica (usually polymeric) will not react with ammonium molybdate and must be digested with sodium bicarbonate to be converted to a reactive form.

Silicic acid reacts with water and hydrates as follows:

$H_2SiO_3 + 3H_2O$ Ç H_8SiO_6

This hydrated silicic acid reacts with molybdate in the presence of acids to form silicomolybdic acid.

$H_8SiO_6 + 12(NH_4)_2MoO_4 + 12H_2SO_4$ Ç $H_8[Si(Mo_2O_7)_6] + 12(NH_4)_2SO_4 + 12H_2O$

This silicomolybdic acid is then reduced to a blue color (heteropoly species) by an amino naphthol sulfonic acid for low concentrations.